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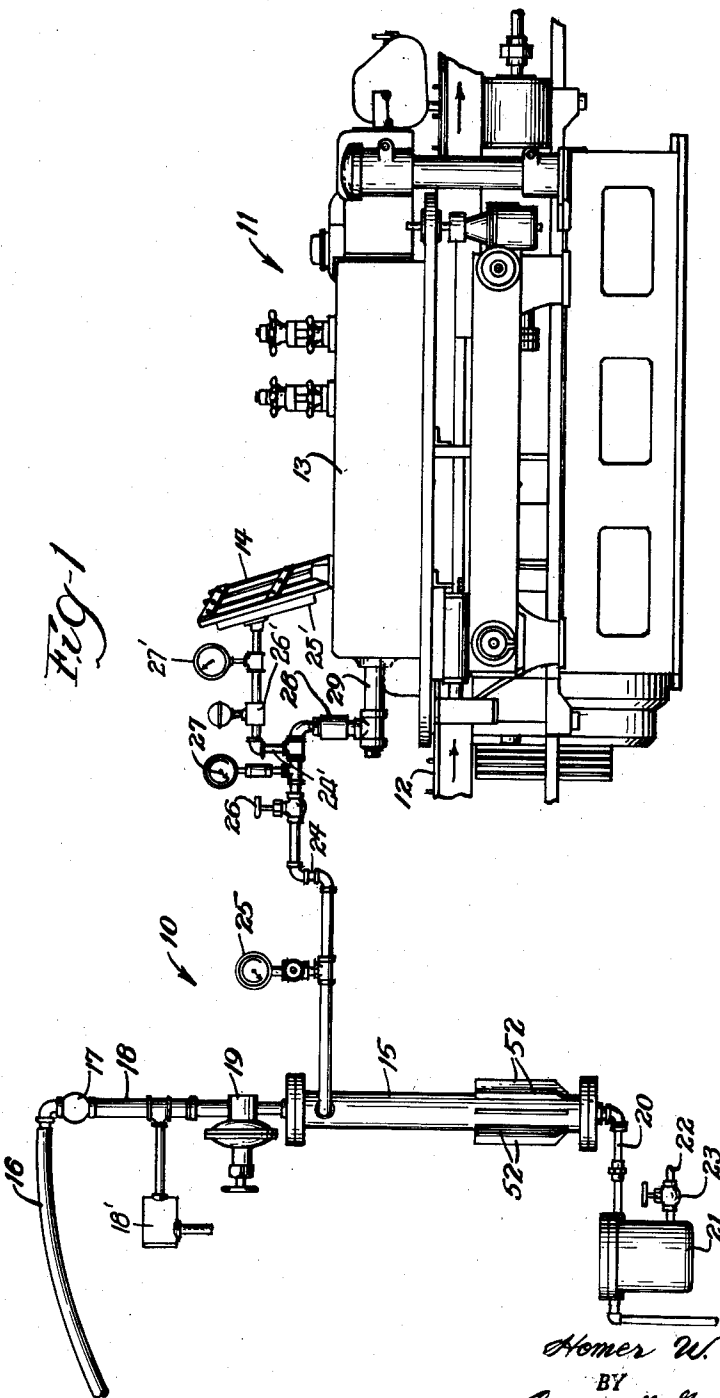
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STEAM TEMPERATURE AND QUALITY CONTROL METHOD AND APPARATUS

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3 Sheets-Sheet 1



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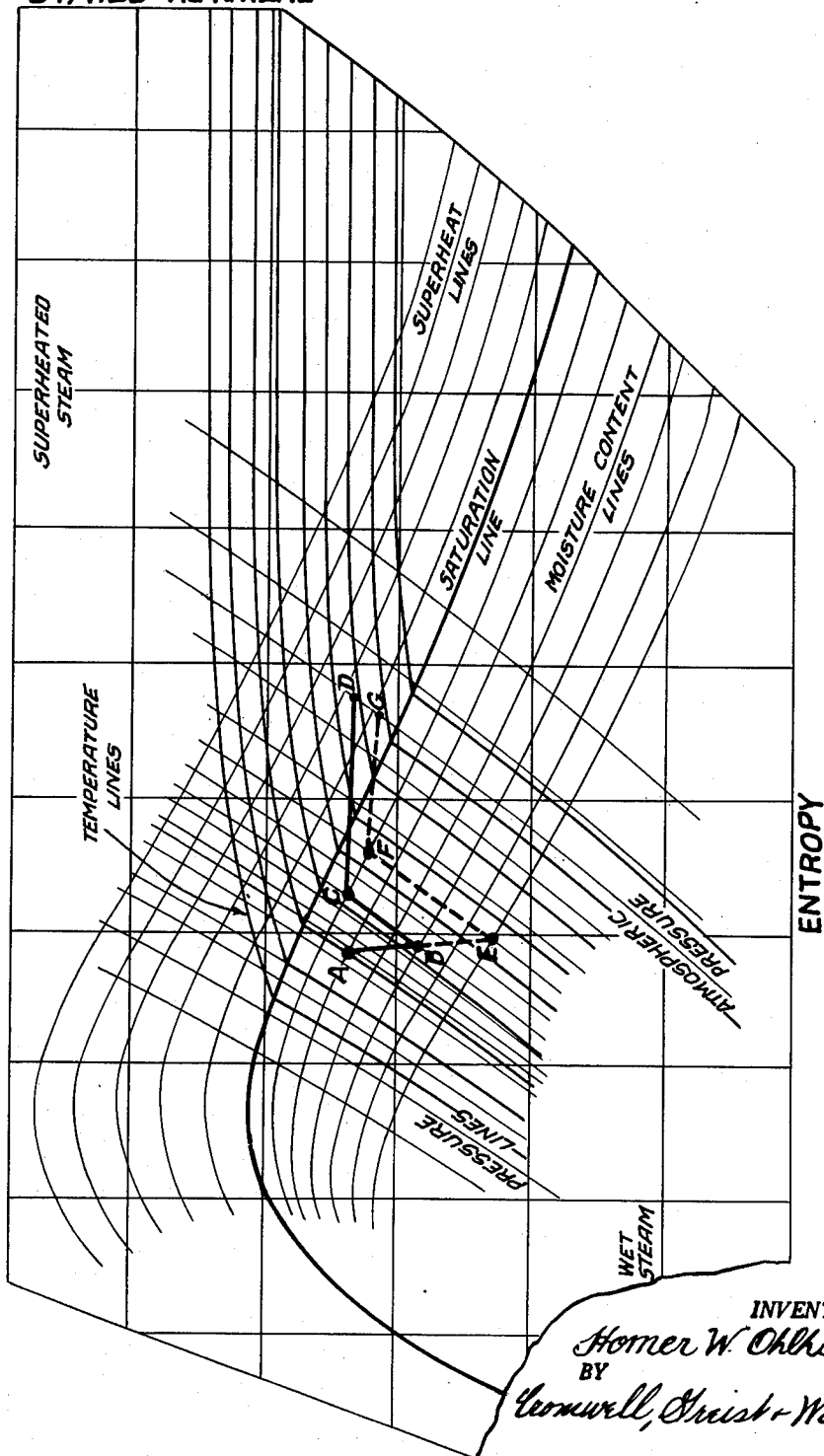
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STEAM TEMPERATURE AND QUALITY CONTROL METHOD AND APPARATUS

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The present invention is directed to a new and improved method for controlling the working temperature and quality of steam for various uses, particularly in the operation of food product container capping machines.

Container capping machine operation of the type disclosed in the McElroy et al. Patent No. 2,876,605 involves the introduction of steam into the machine for several purposes. A food product undergoing hermetic packaging may or may not be heated by the steam to sterilization temperatures as the case may be, but the steam is trapped in the top head or vacuum space of the container following application of the cap or closure member thereto to ultimately form a suitable vacuum therein following cooling of the closed container. With the advent of relatively widespread use of plastisol gasket materials which are usually carried by the cap for sealing engagement with the glass finish of the container, the steam is useful in softening the gasket materials during cap application to provide for proper hermetic sealing imbedding or engagement of the glass finish with the gasket materials.

As generally practiced, steam is applied to a capping machine from a central plant steam generating source and it is difficult to control the generated steam pressure and obtain a continuous source of steam which provides constant temperature and steam quality (entrained moisture content). Accordingly, the quality of the steam introduced into the capping machine may be such that excessive condensation occurs within the head space of the containers following sealing thereof. Furthermore, the temperature of the steam may vary considerably to an extent that product and gasket material overheating or underheating occurs. Product overheating may be quite serious particularly in connection with the treatment of food products which are especially heat sensitive. Gasket material overheating may result in the inability to obtain and maintaining of a hermetic seal as, for example, by reason of the gasket material being heated to an extremely soft, mushy or runny condition resulting in undesirable gasket material relocation in the cap and/or ineffective gasket material contact with the glass finish of the container. These problems are accentuated in capping machines operated at high speeds on the order of about 400 or more jars or containers per minute. It will be appreciated that the temperature conditions at high speed operation are rather critical from the standpoint of control of capping uniformity.

In connection with the gasket materials of the plastisol type, those in use at the present time are made from a paste-forming resin plasticizer mixture. Such material is thermo-plastic and becomes more plastic and subject to flow as the temperature of the mixture is increased. For consistent efficient sealing operations at higher capping speeds, it is necessary that the heating of the gasket material be controlled in order to maintain the desired plasticity of the sealing material to obtain uniform application in establishing and maintaining an efficient hermetic seal. If the temperature of the material is too low, it is difficult to apply the cap carrying the gasket material properly on the glass container. Similarly, if the temperature is too high the gasket material becomes too soft and mushy to be not only subject to displacement within the cap but to be also subject to ineffective sealing contact with the

2

glass finish. The temperature control problems described in connection with plastisol gasket materials are common to all of the paste-forming resin plasticizer mixtures now used and such mixtures are readily available on the market with varying compositions. For a particular capping operation, a specified plastisol gasket material composition may be used and it will be appreciated that the present invention deals with the controlled heating of all types of plastisol gasket materials.

It is an object of the present invention to provide a new and improved method of adjusting and controlling the temperature and quality of steam supplied from a steam generating source, the control being such that the steam upon expansion to atmospheric pressure on the order of "flashing" without work has a specified temperature within reasonable tolerances and is in a state of superheat.

A further object taken in conjunction with the foregoing object is to utilize the new and improved method of the present invention in conjunction with a container capping machine whereby steam supplied from a generating source under variable pressure is conditioned to obtain temperature and quality control thereof for introduction into a capping machine at a predetermined temperature and in superheated condition.

Still a further object of the present invention is to provide a method of adjusting and controlling the temperature and maintain in superheated condition steam delivered to a container capping machine to provide for uniform, cap gasket conditioning, and container vacuumization; the invention further including the provision of a preferred form of apparatus for utilization in a steam quality and temperature control system, the apparatus permitting controlling the pressure at a predetermined value while reducing the temperature of the steam delivered thereto and providing for flashing discharge thereof under controlled conditions into a capping machine.

Other objects not specifically set forth will become apparent from the following detailed description of the invention made in conjunction with the accompanying drawings wherein:

FIG. 1 is a fragmentary elevation of a container capping machine system including as a part thereof the steam temperature and quality control apparatus and system of the present invention;

FIG. 2 is an enlarged, fragmentary, vertical section of the steam temperature and quality control tank forming an important part of the system of FIG. 1;

FIG. 3 is a transverse section of the tank of FIG. 2 taken generally along lines 3-3 therein; and

FIG. 4 is a fragmentary and diagrammatic representation of a portion of a standard Mollier chart illustrating the functioning of the steam temperature and quality control system of the present invention.

Briefly, the method of the present invention providing for the adjusting and controlling of the superheat temperature of steam delivered to a container capping machine or other suitable steam utilization apparatus includes a controlled pressure reduction of steam supplied from a steam generating source with the pressure reduction occurring under temperature reduction conditions and further under conditions which promote an increase of the entrained moisture content of the steam. Upon the steam reaching a degree of relatively low quality, the entrained moisture is removed therefrom to an extent approaching saturation while maintaining constant steam pressure. The steam is then flashed to atmospheric pressure such as in a capping machine during which flashing the steam is transformed to a superheat condition without substantial heat content loss. The controlled conditions under which the steam is handled as described provides for a superheated, controlled temperature steam

supply in the capping machine at substantially atmospheric pressure.

FIG. 1 illustrates a steam conditioning and supply system 10 connected to a known type of container capping machine 11 similar to that described in the aforementioned patent. This machine generally includes an endless conveyor 12 passing through the cap application portion 13 of the machine in the direction of the arrows. The conveyor 12 carries a series of glass jars or the like appropriately filled with product and caps are suitably fed into the capping portion 13 of the machine along a feeder mechanism 14. The machine 11 functions to automatically apply the caps to the opened tops of the jars and hermetically seal the same in the known manner. The caps may be of any suitable type, such as the press-on or rotatable types, having applied thereto thermo-plastic gasket material formed from plastisol mixtures. The gasket material is applied to the inner surface of the cap in the same position therein as known rubber ring gaskets and steam injected into the cap application portion 13 of the capping machine 11 heats up the plastisol gasket material carried in each cap to adequately soften the same for the obtaining of efficient hermetic sealing engagement with the glass finish of the jars. Due to the high rate of speed at which capping machines of this type are operated, it is usually necessary to provide means to preheat the caps as will be described.

The steam conditioning and control system 10 as illustrated in FIG. 1 generally includes a quality control chamber or tank 15 provided with steam inlet means which comprises a flexible pipe 16 delivering steam from a suitable steam generating source (not shown) through a strainer 17 which removes any solid particles, a purifier 18 of known type which removes slugs of water through a trap 18' and a pressure regulator valve 19 of any suitable type into the tank 15 through the top thereof. The bottom of the tank 15 has attached thereto a water condensate discharge pipe 20 having a steam trap 21 mounted therein which in turn is provided with a bleed line 22 controlled by a suitable valve 23.

Conditioned steam is discharged from the tank 15 through steam outlet means which communicate with the interior of the tank at least near the top thereof. The outlet means includes a steam flow line 24 formed from a series of interconnected pipes and joints with the line including therein a tank pressure gauge 25, a steam flow regulating valve 26, a steam flow pressure gauge 27, an expansion or pressure release orifice 28 and a steam discharge nipple 29 which is suitably attached to the cap application portion 13 of the capping machine 11 for the discharge of steam thereinto.

For cap preheating purposes, a portion of the steam delivered through the line 24 may be taken therefrom through a line 24' interposed ahead of the expansion orifice 28. The line 24' is connected to a known type of orifice plate 25' which is mounted on the cap feeder mechanism 14 to discharge steam through the feeder mechanism into contact with the caps delivered therealong to preheat the caps and assure the obtaining of adequate preheating of the plastisol gasket material carried thereby to accommodate high speed operation of the capping machine. The line 24' will preferably include a throttling valve 26' to control the amount of steam delivered to the orifice plate 25'. The line 24' will further preferably include a gauge 27' to provide an indication of the amount of steam pressure supplied to the orifice plate 25' to determine the rate of flow of steam through the line 24'.

The various elements described forming the steam conditioning system 10 may be of any suitable design and arrangement as long as they are capable of providing the steam temperature and quality control aspects of the invention to be described in detail. The valves, pressure gauges and expansion orifice are of known type and for this reason are not illustrated and described in detail. However, the quality control chamber or tank 15 is pref-

erably fabricated in the manner illustrated in FIGS. 2 and 3.

As shown in FIGS. 2 and 3, the tank 15 is formed from an elongated cylindrical shell 30 which may externally thereof be covered with suitable insulating material (not shown). The top end of the shell 30 has fixed thereabout an annular flange 31 supporting a gasket 32 which is compressed thereagainst by a top closure plate 33. The plate 33 carries a series of circumferentially spaced bolts 34 which are received through suitable apertures in the flange 31 and which draw the plate 33 into sealed engagement with the gasket 32 and the flange 31 by nuts 35 threadedly received thereon. Washers 36 are disposed between the nuts 35 and the adjacent face areas of the flange 31.

The plate 33 has received therethrough a steam inlet pipe 37 which projects upwardly beyond the top surface of the plate 33 and is suitably externally threaded for attachment to the pressure regulator valve 19 of FIG. 1. The pipe 37 is fixed by welds to the plate 33 to provide for supporting thereof in downwardly projecting relation within the shell 30 in off-centered position therein. Thus the pipe 37 extends downwardly in the shell 30 with its bottom discharge end in close association with the bottom portion of the shell 30.

The pipe 37 has fixedly secured thereto a collar 38 which is in abutment with the uppermost of a pair of cartridges 39 and 40 each having received therein suitable steam diffusing material such as stainless steel wool or the like. The cartridges 39 and 40 are held in place on the pipe 37 near the bottom portion of the shell 30 by an adjustable collar 41 which is located on the pipe 37 by a set screw 42 carried thereby.

The bottom of the shell 30 has received thereabout an annular closure flange 43 having attached thereto a bottom cover plate 44 by means of a plurality of circumferentially spaced bolts 45 and nuts 46. Washers 47 are received between the nuts 46 and the adjacent face portions of the flange 43 and a gasket 48 provides a seal between the bottom closure plate 44 and the flange 43. The bottom plate 44 has extending therethrough an annular water discharge sleeve or pipe 49 which is offset relative to the discharge end of the pipe 37 and which is internally threaded to receive therein one end of the water discharge pipe 20 which communicates with the steam trap 21 as shown in FIG. 1. The sleeve 49 projects upwardly into the tank for a purpose to be described. The tank structure is completed by the provision of a steam discharge fitting 50 located near the top portion of the shell 30 and having threadedly received therein a pipe section 24 forming a part of the steam discharge line of the system shown in FIG. 1.

General operation of the steam conditioning system 10 may be described by reference to FIGS. 1 and 2. Steam is supplied to the tank 15 from any suitable steam generating source (not shown) through the flexible pipe 16, strainer 17, purifier 18 and pressure regulator valve 19. It will be appreciated that steam for capping machine operation purposes is normally supplied from a central steam generating portion of a plant which supplies steam to any number of capping machines. The pressure of the steam supplied may vary considerably and the pressure regulator valve 19 is operated to control the introduction of steam into the tank 15 through the pipe 37 to maintain a predetermined pressure in the tank 15. The steam flows downwardly through the pipe 37 into the bottom of the shell 30 in which a body of water condensate 51 (FIG. 2) is maintained by reason of the projecting of the sleeve 49 into the tank 15. The quality of the steam introduced into the tank 15 is not controlled in any particular respect. The temperature may also vary considerably depending upon this. However, upon the entering of the steam into the tank in association with the body of water 51, the quality of the steam is reduced materially to a virtually controlled low quality. In other words, by the presence of the water 51, the steam is provided with a

5

relatively high moisture content of entrained water and is prevented from being saturated or from transformation to superheated condition.

The steam entering the tank 15 has its temperature reduced by loss of heat transferred through the shell 30 to air cooled fins 52 which are suitably mounted on the exterior of the shell 30 and which are circumferentially spaced thereabout as best illustrated in FIG. 1. The temperature of the steam is reduced under constant pressure conditions as controlled by the setting of the pressure regulator valve 19 and the controlled conditions provided by the tank 15. The steam rises through the diffusing cartridges 39 and 40 to eliminate the formation of any jet streams within the tank 15. The controlled constant pressure occurring within the tank 15 accompanied by the vertical rising of the steam therein into the upper portion of the tank 15 permits and provides for steam quality improvement by the loss of moisture therefrom which is collected in the body of condensate 51 at the bottom of the tank 15. Thus the entrained moisture content provided by quality reduction in the presence of the condensate body 51 is removed during the rising of the steam within the tank 15 toward the outlet fitting 50. In this respect them, the steam quality approaches saturation under constant pressure conditions with the result that the steam outlet line 24 receives from a tank 15 steam at a predetermined pressure which is of good quality approaching saturation, with a known B.t.u. content per pound.

Referring particularly to FIG. 1, the pressure of the steam discharge from the tank 15 is indicated by the gauge 25 as controlled by the setting of the regulator valve 19. The steam flows past the pressure gauge 25 through a flow regulating valve 26, and then past a steam flow pressure gauge 27 and into a steam expansion orifice 28 of any suitable type. The orifice 28 may merely be a fixed restricted opening built into a pipe. The important requisite of the orifice 28 is that flashing occurs without appreciable heat content loss. The steam is then immediately flashed through the orifice 28 and the inlet fitting 29 into the interior of the cap application portion 13 of the capping machine 11 to atmospheric pressure or thereabouts with the result that the steam is superheated to a controlled temperature because of the known B.t.u. content.

As previously described, a prescribed quantity of the steam may be diverted through the line 24' to the orifice plate 25' for cap preheating. The orifice plate 25' is such that the steam diverted thereto is flashed through a plurality of orifices to atmospheric pressure in much the same manner as the main supply of steam passed through the expansion orifice 28. Thus the steam used for cap preheating purposes will be flashed to atmospheric pressure without any appreciable heat content loss and the temperature of superheat of the steam so used is the same as that flashed into the cap application portion 13 of the capping machine.

FIG. 4 illustrates the phenomena occurring in the steam conditioning system 10, the operation of which has been described. FIG. 4 is a diagrammatic, fragmentary representation of a portion of the Mollier chart which basically plots entropy against enthalpy in B.t.u./lb. Related to these values are temperature, pressure and moisture content values with the portion of the chart illustrated being generally subdivided by the saturation line into areas of wet steam and superheated steam.

Two examples of steam supplies undergoing temperature and quality control in the manner described above are graphically illustrated in FIG. 4. The tank 15 may be supplied with steam having the properties designated at A in FIG. 4. It will be seen that such steam has a certain moisture content and a specified temperature and pressure. Upon controlled introduction into the tank under pressure and temperature reduction conditions, the properties of the steam will change from A to B. At this

6

point plotted on the chart of FIG. 4 it will be noted that the pressure of the steam has been reduced, the temperature of the steam has been reduced and the moisture content of the steam has been increased. During upward flow of the steam within the tank 15 toward the outlet fitting 50, the pressure and temperature of the steam is maintained constant and the quality of the steam will vary to the conditions specified at C on the graph. As previously described, the rising of the steam within the tank 15 under constant pressure and temperature conditions results in improving the quality of the steam to an extent that the same approaches saturation and, with this improvement in quality, the B.t.u. rating per pound of the steam increases to a known and controlled value. The steam will not pass over the saturation line due to the presence of the collected condensate 51. Excess condensate overflows the sleeve 49 and is removed from the tank 15.

Upon discharge of the conditioned steam from the tank through the expansion orifice 28 into the capping machine, the pressure drop occurring from tank pressure to atmospheric pressure, the properties of the steam will vary from C to D as plotted on the chart of FIG. 4. It will be particularly noted that steam does no work during this "flash" and the changes in properties occur along substantially constant enthalpy values with only slight drop in enthalpy with the result that the steam is expanded into the superheat area and crosses the saturation line to provide a source of steam for capping machine operation which is superheated and of predetermined temperature.

From the foregoing, it will be appreciated that the tank 15 functions to cooperatively control with the pressure regulator valve 19 the pressure of the steam up to the point of "flashing" to atmosphere thereof and thus controls the temperature of the "flashed" steam. The tank 15 further functions to control the moisture content of the steam by first increasing the same to maintain the steam well below the saturation line and then to permit moisture content reduction to an extent approaching steam saturation. The several controls provided as described function under widely varying circumstances to condition the steam within an area on the Mollier chart of FIG. 4 from which "flashing" to atmosphere results in the provision of superheated steam at a desirable temperature.

To illustrate the obtaining of steam superheated to a lower temperature than the atmospheric steam at D in FIG. 4, the same steam source A may be reduced to a much lower pressure as represented at E on the chart by suitable operation of the pressure regulator valve 19. The steam at E also contains a higher moisture content and upon movement upwardly in the tank 15 toward the outlet fitting 50, the pressure remains constant and the moisture content approaches saturation. Upon "flash" to atmosphere of the steam from F to G, the resultant superheat temperature of the steam is lower. Thus, controlling the pressure maintained within the tank 15 by regulation of the valve 19, the steam supplied at atmospheric pressure within the capping machine 11 may be at a variable predetermined superheat temperature so as to alleviate the undesirability of excessive condensation within the capped container. The desired temperature of the steam injected into the capping machine will vary with the particular plastisol gasket composition used so as to control the degree of softness of the gasket material within a range providing for efficient glass finish sealing action.

The following is an illustrative example of suitable operation of the system illustrated and described in FIG. 1 and should not be construed as limiting to the scope of the present invention.

The capping of glass jars containing a fruit product maintained at a temperature of 155° F. was carried out in a standard capping machine having steam injected therein at approximately atmospheric pressure. The steam supplied from the plant generator was at 125 p.s.i.g. having a temperature of about 350° F. The steam was intro-

duced into the expansion tank 15 to an extent that a pressure within the tank of about 55 p.s.i.g. was maintained by referring to the pressure gauge 25 and controlling the regulator valve 19. The temperature of the steam within the tank 15 was reduced to about 290° F. The steam upon introduction into the tank 15 was transformed into a low quality or relatively high moisture content steam. Upon continued rising of the steam within the tank 15 under constant pressure conditions, namely, 55 p.s.i.g., the quality of the steam was improved to an extent that the steam was near saturation condition. The steam was "flashed" at substantially constant enthalpy through orifice 28 to atmosphere with a superheated temperature of 240° F. This temperature was maintained consistently throughout a substantially long period of operation. Jars were capped by the machine during this period of operation at the rate of approximately 450 per minute. The plastisol gasket material used in the caps applied to the jars were adequately softened to the desired degree and efficient hermetic sealing action was consistently obtained. Upon periodic checking of the capped containers, no excessive moisture condensation was found in the head spaces thereof.

The level of collected condensate 51 at the bottom of the tank 15 may be varied considerably, and by way of example only, a ¼ inch deep collection is entirely adequate. Excess condensate may be removed from the trap 21 through the line 22 by operation of the valve 23. The air cooled fins 52 may be readily replaced by any suitable temperature reduction means such as a water jacket. Suitable insulation (not shown) on any parts of the system described may be utilized to the extent desired. The steam conditioning system 10 is operative even under a relatively low pressure differential, this feature being important in extending the usefulness thereof. In other words, a pressure differential of about 15 p.s.i. as between the steam supply and the pressure as read at gauge 25 is all that is necessary for proper functioning of the steam conditioning system. While the operation of the system has been described in connection with atmospheric pressure operation of a capping machine, it will be appreciated that the principles of the present invention are also applicable to machine operation under pressurized steam conditions.

Obviously certain modifications and variations of the invention as hereinbefore set forth may be made without departing from the spirit and scope thereof, and therefore only such limitations should be imposed as are indicated in the appended claims.

I claim:

1. The method of adjusting and controlling the superheat temperature of steam delivered to a container capping machine to provide for uniform heating of cap gasket material and container vacuumization; said method comprising continuously delivering steam into a quality control chamber at one end thereof, subjecting the steam in said chamber to temperature reduction conditions to

increase the entrained moisture content thereof, flowing the expanded steam through said chamber toward the other end thereof while maintaining constant pressure, removing entrained water from the steam during flow thereof toward said other end to an extent that the steam approaches saturation, and flashing the steam to atmospheric pressure from said other end of said chamber into a capping machine in superheated condition.

2. The method of adjusting and controlling the superheat temperature of steam delivered to a container capping machine to provide for uniform heating of cap gasket material and container vacuumization; said method comprising continuously delivering steam into a quality control chamber at one end thereof, moving the steam into association with a body of water collected in said one end of said chamber under temperature reduction conditions to increase the entrained moisture content thereof, flowing the steam through said chamber toward the other end thereof while maintaining constant pressure, removing entrained water from the steam during flow thereof toward said other end to an extent that the steam approaches saturation, and flashing the steam to atmospheric pressure from said other end of said chamber into a capping machine in superheated condition.

3. A steam quality and temperature control system comprising a steam chamber which is vertically elongated and having steam inlet means extending downwardly through the top thereof into close steam discharge association with the bottom thereof, steam delivery regulator means forming a part of said inlet means to control the pressure of steam delivered into said chamber, water discharge means extending through the bottom of said chamber and projecting thereinto to maintain a body of water in said chamber, steam coolant means in the form of spaced radially projecting fins mounted exteriorly about said chamber in association with the bottom portion thereof to facilitate steam temperature reduction, steam outlet means communicating with the interior of said chamber at least near the top thereof to discharge from said chamber conditioned steam, steam diffusing means mounted in said chamber through which the steam rises and is distributed in said chamber to avoid the establishing of jet streams, fixed pressure release means forming a part of said outlet means to release and flash the steam to atmospheric pressure, and steam discharge regulator means in said outlet means between said expansion means and said chamber to aid in controlling the rate of flow of the released steam.

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